NATIONAL SCIENCE & ENGINEERING WEEK

nsew.org.uk

Explore the future

Part of the British Science Association's National Science & Engineering Week activity pack series. **www.nsew.org.uk**

BRITISH SCIENCE ASSOCIATION

Department for Business, Innovation & Skills

Primary activity pack - Explore the future

About this pack

This activity pack, aimed at 5-11-year-olds, contains a range of different activities based on the theme "Explore the future" for National Science & Engineering Week 2014.

The pack has been designed to provide easy-to-do activities that are fun and engaging, and will hopefully generate a "wow factor" amongst pupils. They can be used in both formal and informal places of learning to complement and enrich the curriculum.

Activities 1-12 are short and simple, using resources that can be sourced cheaply and easily. They could form a central part of a school's activity week, or they could be used as extra activities to support existing schemes of work. Although activities 1-12 can be completed independently or in small groups, a further activity is included which is designed specifically to provide a group challenge.

In addition to these activities, the pack contains two investigations that are suitable for use as part of the CREST★ Investigators scheme. There is one CREST Star activity and one CREST SuperStar activity.

In Star activities (usually for 5–7-year-olds) children discuss materials, solve problems and share experiences. In SuperStar activities (usually for 7–11-year-olds) children work independently, discuss ideas and how to test them, solve simple problems and decide how to share results.

More information about CREST★ Investigators can be found on the British Science Association website (http://www.britishscienceassociation.org/creststar).

Contents

Section 1: space & satellites

A discovery in space could lead to something that changes life on Earth. For example, if scientists can understand what happens outside of Earth's atmosphere in the stars and galaxies, they might be able to stop global warming. They might be able to harness a new form of energy. They might even find intelligent life!

Activity 1: planetarium

You will need

Shoebox, scissors, black paper, pen or pencil, constellation chart (e.g. from http://kids.lovetoknow.com/wiki/Printable_Star_Charts), sticky tape, torch, pin

What you do

Use the scissors to carefully cut a circular hole at one end of the shoebox, just big enough for the torch to fit into. Cut a large rectangle out of the other end of the shoebox.

Cut several pieces of black paper, making sure they are each big enough to just cover the rectangular hole at the end of the shoebox. Look at the star chart and use a pen or pencil to copy a different constellation onto each piece of paper. CAREFULLY use a pin to make holes where you have drawn the 'stars'.

Place one of the pieces of paper over the rectangular hole in the shoebox, using sticky tape to keep it in place.

Turn off the lights and make the room as dark as you can. Hold the shoebox in one hand and the torch in your other hand. Turn on the torch and push it through the circular hole in the shoebox, shining it through the box and onto a blank wall.

Ask your classmates if they recognise and can name the constellation. They could use the constellation chart to help them.

Repeat with the different pieces of paper creating the different constellations.

You could try…

Find out how moving the box closer or further away from the wall changes what you see. You could also investigate the differences when more or less powerful torches are used.

Astronomers usually use telescopes, but you could try using binoculars to look at the night sky. Take a look at the moon and you may be surprised how much more you can see using binoculars.

What's happening?

A constellation is a group of stars that form a pattern. Constellations have been used for many things over the years. Ancient Greeks thought the Gods made them. Farmers used them to tell if it was winter, summer, autumn or spring. Sailors also used them to help know which way they were going.

Light from the torch reaches the piece of black paper with holes representing stars in a constellation. It can pass through the holes, but not through the black paper. Narrow beams of light are seen coming through the holes. These beams continue in straight lines and can be seen on the wall.

Activity 2: fruit and veg solar system

You will need

One pea, one blueberry, two cherry tomatoes, one watermelon, one large grapefruit, one large apple, one small orange, list of planets (Earth, Jupiter, Mars, Mercury, Neptune, Saturn, Uranus, Venus), scissors

What you do

Cut out the names of the planets to produce eight labels.

Decide which pieces of fruit or veg represent each planet based on their size (your teacher can help with this). Match the fruit and veg to the labels, then place them in order from the closest to the Sun to the planet that is furthest from the Sun.

If the planets were the size of these fruit and veg, discuss how big you think the Sun would be.

You could try…

The diameter of the Sun is 1,391,900 kilometres. If you make a scale model of the solar system in which the Sun's diameter is 1 centimetre, these are the diameters of the planets and their distances from the Sun.

Planet	Diameter (mm)	Distance from Sun (m)
Mercury	0.003	0.4
Venus	0.008	0.8
Earth	0.009	1.1
Mars	0.005	1.6
Jupiter	1.03	5.6
Saturn	0.8	10.3
Uranus	0.3	20.6
Neptune	0.3	42.5

Using this chart put your fruit and veg planets in the correct order, making sure each one is the correct distance from the Sun. You will need a large space, such as a playground.

What's happening?

You've made a model of the solar system. The fruit and veg have been used as the planets. A scale model of the solar system shows the different sizes of the planets and the distances between them – but it is a smaller version than the real thing! It might surprise you to see how much bigger some planets are than others. It might also surprise you to see how far away some planets are.

Activity 3: how bright are the stars?

You will need

Scissors, cardboard (approximately the size of half a cornflakes paquet), ruler, coloured cellophane, sticky tape

What you do

Cut four rectangular holes (each about 2 x 2.5 cm) out of the cardboard. Make sure the holes are lined up in a row.

Put cellophane over the cardboard so that it covers all four holes. Hold the cellophane in place with sticky tape. Use another sheet of cellophane to cover just three of the holes – these three holes will now be covered by two layers of cellophane. Cover two of these holes with a further sheet of cellophane, and then cover just one of these two holes with more sheet of cellophane. Each time, use sticky tape to hold the cellophane in place.

You now have a piece of cardboard with four rectangle holes: one covered with one layer of cellophane, one with two layers of cellophane, one with three layers and one covered by four layers. This is your star brightness detector.

When it's dark and the sky is clear, use the brightness detector to look up at the stars. Only the brightest stars will be seen through the four sheets of cellophane.

Try to find a star that you can see with one sheet but not with two sheets. Now find a star you can see with two sheets but not three, and a star you can see with three sheets but not four. Finally, can you see any stars through all four sheets? What brightness of star is most common?

You could try…

Use some constellation charts (e.g., from http://kids.lovetoknow.com/wiki/Printable_Star_Charts) to find constellations in the night sky. Choose a constellation that you can see, and use your brightness detector to compare its stars. You could mark a chart to show which stars are the brightest, which are the least bright and those that are somewhere in between.

What's happening?

A star is a huge ball of very hot gas. When you look at the night sky, especially outside a town or city where there is less pollution, you can see thousands of them. How big and bright a star is may depend on how hot it is. The hottest stars are usually the biggest and brightest. Our Sun is a large star, but a couple of stars have been shown to be more than 100 times its size.

Section 2: the future of food, plants & animals

As the world's population grows, scientists have concerns that we might not have enough food for everybody. It's obvious that we need enough food to survive, but it's also important that it tastes nice, it's nutritious, and that we don't use too much land to produce it.

Activity 4: organic food

You will need

Organic milk, non-organic (ordinary) milk, organic cheddar cheese, non-organic cheddar cheese, organic yoghurt, non-organic yoghurt, drinking water, knife, plastic cups, plastic spoons, paper towels, paper, pen or pencil

What you do

Find five volunteer tasters. Provide each taster with samples of each type of milk, cheese and yoghurt – about 10 ml samples of milk and yoghurt, and 1 cm chunks of cheese (CAREFULLY use the knife to cut the cheese). Provide the milk and yoghurt in plastic cups (with plastic spoons to taste the yoghurt) and put the cheese on paper towels. MAKE SURE that anyone handling food washes their hands thoroughly, before and after.

Label each sample cup with a letter and make a note of whether it's organic or non-organic, but don't let the tasters know (e.g., A = organic milk, B = non-organic milk, C = non-organic cheese, D = organic cheese, E = organic yoghurt, F = non-organic yoghurt).

Ask the tasters to taste the milk and decide which sample they think is organic and which is non-organic. Ask them which they prefer and to describe any differences in taste. Make a note of their responses.

Ask the tasters to take a sip of water to clear the taste of milk from their mouth. Then repeat the taste test with the yoghurt and cheese (clearing the taste from their mouth with water between tests).

Write up your results.

You could try…

Carry out tests similar to those used by scientists at the University of Oxford. They found that using different coloured spoons made people think the yoghurt tasted different. They also found that using different coloured cutlery with different coloured food changed the way someone thought the food tasted.

You could design a test using plain yoghurt and a range of plastic spoons – same shape and size but different colours. You could repeat the test using plain yoghurt that's been coloured with two or three drops of food colouring.

What's happening?

Organic food is made from plants and animals that have been grown using natural fertilisers (such as compost) and without the use of artificial pesticides and herbicides.

Some people argue that organic foods are better for us than non-organic foods. Some argue that organic foods taste better than non-organic foods. What did you find out?

Taste tests are very important when developing new foods and other products. Tests are designed carefully to make sure everything that can affect taste is considered. It is also important to make sure that the tests are designed to produce reliable data.

Activity 5: plants to treat disease

You will need

Microscope, microscope slides, variety of plant leaves (e.g. herbs such as basil, mint, sage and thyme), paper and pencil

What you do

Put a small piece of a leaf on a microscope slide. Place the slide on the microscope. Ensure that the microscope is in the lowest power position (the shortest lens above the slide). Bring the leaf into focus, increasing the lens power as necessary. You may need to ask your teacher to help with this.

Draw and/or describe what you see. Can you see any 'structures' on the leaf? They might look like tiny hairs or tiny drops of water.

Carefully take the leaf off the microscope slide and rub it gently between your fingers. Describe what – if anything – you can smell.

Repeat with different leaves.

Is there a link between what you saw under the microscope and whether or not the leaf produced a smell when rubbed?

You could try…

Find out about the link between willow trees and aspirin (the most commonly used form of mild pain relief in the world).

Aspirin is well known. It's used to relieve pain and bring down fevers. Since 1970 it has also been used to help prevent heart disease. Aspirin is manufactured by a chemical process. Find out about the link between aspirin and the bark from willow trees.

You could also try finding out which illnesses can be treated with substances obtained from (a) daffodils, (b) foxglove, (c) deadly nightshade, (d) rosy periwinkle.

What's happening?

You can look at the surfaces of plants with a microscope to see if there are any tiny hairs. These hairs contain special cells called trichomes which, when rubbed, produce a smelly resin. Some of these resins have been found to contain compounds that are useful medicines. For example, you might find out about the link between willow trees and aspirin. Investigating the processes that happen in plants helps scientists to understand the chemistry of these substances.

Activity 6: capture-mark-recapture

You will need

Packet of dried pasta, permanent marker pen, plastic carrier bag (large enough to hold the packet of pasta), paper, pen or pencil

What you do

Empty the packet of pasta into the bag. Estimate how many pasta pieces there are in the bag and make a note of your estimate.

Take 25 pasta pieces out of the bag, mark each piece clearly with the permanent marker pen, and then put them all back into the bag. Shake the bag to thoroughly mix the pasta pieces.

Without looking in the bag, randomly take out 25 pasta pieces and place on a table. Make a note of how many pasta pieces were 'recaptured' (i.e. have a pen mark on them).

Use the following equation to work out the population of pasta pieces:

$$\frac{\textbf{25 (number of marked pasta pieces) X 25 (number of pasta pieces captured)}}{\textbf{number of pasta pieces recaptured (marked pieces captured)}}$$

= Total population

Ask your teacher what the actual number of pasta pieces are and compare with your calculated population.

You could try…

Repeat the process ten times; making sure the bag is shaken to mix the pasta pieces before each capture. Calculate the 'average' of your ten attempts to find out if the calculated population is then closer to the actual population.

You could also try taking 25 pasta pieces and marking 10 of them with a red marker pen and the other 15 with a blue marker pen. Put them back in the bag. Without looking in the bag, randomly take out 25 pasta pieces and place on a table and count how many 'captured and marked' pasta pieces were 'recaptured'.

What's happening?

It is not possible to count all the plants and animals in a habitat. Scientists take small areas, count the number of plants and then estimate how many there are in the whole habitat. Plants stay where they are, so this works well. However, animals move around, so the method doesn't work for them.

Instead, biologists often use 'capture-mark-recapture' to estimate the number of animals in a whole habitat.

A sample of the population is captured, marked, and released. The released marked animals spread out and mix with animals that weren't marked. After a while a second sample is captured. The numbers of marked and unmarked animals are counted and the proportion of marked animals calculated. The number of animals in the whole habitat is estimated by dividing the number of marked animals by the proportion of marked animals in the second sample.

Section 3: communications & transport

The world isn't shrinking, but developments in communications and transport perhaps make it feel like it is. As we moved from the first telephones to the modern day smartphone, the ease and speed with which we communicate has increased amazingly. The internet allows unimaginably vast amounts of data to be stored and shared almost instantly. Technology in Formula One motor racing has produced cars that go quicker than ever before. Ever bigger aircrafts are being built.

Can you imagine how technology and transport might develop in the future?

Activity 7: fonts, bytes & bits

You will need

A computer with Microsoft Word

What you do

Open a new Word document. Write about 25 lines of text. It doesn't have to make sense – it just needs to be a string of different letters. Do not change the font or the size of the text. The text will be in the 'default' font, i.e., what the computer chooses automatically.

Create a new folder called 'Fonts' and save the Word document using the file name 'Default'.

Make a copy of the 'Default' file. Open this copied file and embed the font. Ask your teacher how to do this or go to http://support.microsoft.com/kb/290952. Save the file and then change the file name to 'Default embed'.

Make another copy of the 'Default' file. Open this new copied file and change the font (e.g. Chiller). Save the file and then change the file name to the font you chose. As before, make a copy of this file, open it, embed the font, save the file and change the file name (e.g. Chiller embed).

Repeat this process three more times, choosing a different font each time. You should now have 12 Word documents (six pairs – font and font embed) saved in your 'Fonts' folder. Open the folder and make sure the 'Views' option is set to 'Details'. You will now see a list of your saved Word documents showing the file names and the size of each (in kilobytes, KB).

Do different fonts create files of different sizes? Is there a difference between the size of files that have embedded fonts and files that do not have fonts embedded?

You could try…

Find out what happens if you change the size or colour of a font.

You could use a font making program to create your own font. Use your new font in a Word document and save without the font embedded. Copy the file, rename and embed the font. Find out what happens if you open these files on a computer that doesn't have your font loaded.

What's happening?

Fonts are sets of symbols – one symbol for every letter, number or punctuation mark. Word processing programmes (like Word) write a code for each symbol, and tell your computer which font was used. This information is stored when you save the file. Notice that Word only tells your computer which font is used; your computer has to have information about that font to display the words correctly. Your computer has to have the font **installed**. Sometimes, you might use a particular font and send a file to a friend. If their computer doesn't have the font installed, it won't know how to display the symbols the way you want.

How do you get around this? You **embed** the font, so your Word file contains extra information; it makes the file size bigger, but at least you can be sure it will look just the way you want!

Activity 8: how does satellite navigation (SatNav) work?

You will need

A5 photocopy of map (at least two copies), drawing compass, pencil, ruler

What you do

Choose a point on your map and mark it with a pencil.

Measure the distance (in cm) from the top-left corner of the map to your point. Make a note of this measurement. Now measure the distances from the top-right corner and from the bottom-right corner to your point. Make a note of the measurements.

Give an unmarked copy of the map to someone. Ask them to guess where your point is. It's not very easy without any clues! Even if you give them a clue such as "It's near a river", it's unlikely that they will be able to locate your exact point.

Give the person a compass, pencil and the three measurements you took. They should use the compass to draw three arcs: a) with the point of the compass at the top-left; b) with the point at the top-right; and c) with the point at the bottom-right. For each arc, the compass should be set at the appropriate distance as given by your measurements.

The point at which the arcs cross should be the same as the point you marked on your map.

You could try…

On a blank piece of paper, design a dot-to-dot picture. Make the three Global Positioning System (GPS) measurements for each dot. Provide these measurements, along with a blank piece of paper, a pencil, a ruler and a compass, to see if someone can complete the picture.

What's happening?

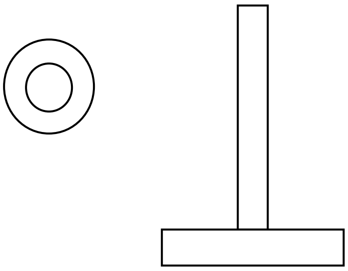
This way of working out the location of something is similar to how the GPS works.

There are lots of GPS satellites orbiting Earth. They have clocks that are all set exactly the same. They all send signals. A GPS receiver (a car SatNav, for example) receives signals from three of the satellites. The receiver's location can be calculated by working out how far it is from the three satellites.

Activity 9: hovering trains

You will need

Ring magnets, wooden rod (diameter a little smaller than the holes in the magnets) fixed to a wooden base.



What you do

Stand the wooden rod upright. Slip one of the ring magnets over the rod and let it fall to the base. Now slip a second ring magnet over the rod and let it fall. What happens?

Tip the two magnets out. Put the first one back on the rod just as you did the first time. Now slip the second magnet on the rod, but make sure it's upside down compared to the first time. What happens this time?

Use more magnets to investigate what happens.

You could try…

Making a 'train' by taping a ring magnet to the bottom of an empty matchbox and designing a 'track' that the train could float on. It's not easy, but you could try making a short section of track (say 10-15 cm).

What's happening?

Magnets have two ends. One is the magnet's north pole and the other is its south pole. You may have played around with bar magnets and learned that opposite poles attract and like poles repel.

In a ring magnet, one side is the north pole and other is the south pole. If two ring magnets are slipped over the wood rod so that either the two north poles are facing one another or the two south poles are facing one another, one magnet 'floats' on the other. Special trains, called maglev trains, use magnets to make them 'float' in the air. This means they can go really fast.

Section 4: energy

The Earth is amazing. It's the only planet in the solar system where life exists. Why is that? Well, it's just the right distance from the Sun to get the right amount of light and warmth, there is oxygen in its atmosphere and it has plenty of water. Because of these conditions, a huge variety of life has evolved, from tiny microorganisms to very large plants and animals. These provide us with food, drink and stores of energy.

Activity 10: which way should my solar panel face?

You will need

A heavy box (e.g. a shoebox containing weights), four thermometers, navigational compass, sticky tape

What you do

Use sticky tape to attach four thermometers to the box, one to each side. Find an area outside that receives sunlight throughout the day. Use the compass to work out where North, East, South and West are. Position the box so that one side faces North, one faces East, one faces South and the other faces West.

Look at the thermometers and make a note of each temperature. Read and record the temperatures on each thermometer every 30 minutes until the end of the day.

Imagine that your head teacher has decided to have solar panels installed. Thinking about the measurements you made, can you suggest to your head teacher which way the solar panels should face so that they get the most energy from the Sun?

You could try…

Make a simple solar panel by slowly trickling water through some clear plastic tubing. Measure the temperature of the water before it goes into the tube and then when it comes out of the tube.

What's happening?

We can learn a lot from people who grow grapes. Across Europe grape vines are grown on south facing hillsides. One of the reasons is that they get more intense light from the Sun and for longer. North facing hillsides are in the shade for longer. This is because of the way Earth moves around the Sun. It is the same with solar panels. We want them to capture as much sunlight as possible, so it's best to place them on a sloping roof that faces south. It's important that it's sloping because the sunlight falls almost perpendicularly and, therefore, is more intense.

Activity 11: the greenhouse effect

You will need

Two empty jars (the same size), two thermometers, colourless see-through plastic bag (big enough to completely cover and seal one of the jars), plastic bag tie, ice cubes (all about the same size), a nice sunny day (!)

What you do

Pour water into each jar to the same level (about three-quarters full). Add two ice cubes to each jar and put a thermometer into the water in each jar. Place one jar in a plastic bag and use the tie to seal the bag. Make sure you can still see the thermometer. Now put both jars outside on a sunny day for at least two hours.

Which jar is the hottest? Which one heats up the quickest?

You could try…

Measure the temperature of the water in each jar every half an hour for three hours. Draw a bar chart to compare how quickly the water in each heats up.

What's happening?

The water in the jar covered with a plastic bag should have become warmer than the water in the other jar. The plastic lets sunlight in. It's absorbed by the water, but the energy radiated back cannot escape the bag. This is mimicking the greenhouse effect that helps keep Earth at a temperature that can sustain life.

Earth's atmosphere is a thin layer of gas. Beyond this layer there is no atmosphere. The water in the jars represents water on Earth (70% of Earth's surface is covered in water – this is why Earth looks blue when seen from space). The plastic bag acts like Earth's atmosphere.

Activity 12: rain in a bowl

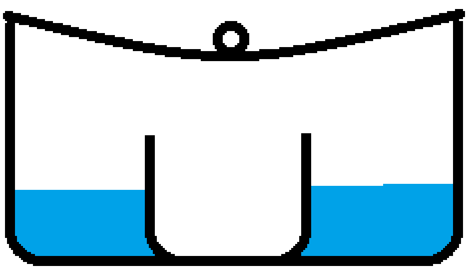
You will need

A large glass bowl, a mug (smaller than the height of the bowl), felt tip pen, cling film, small marble, water

What you do

Stand the mug in the bowl. Pour water into the bowl, making sure that none goes in the mug, until it is halfway up the mug. Make sure that the mug stays standing on the bottom of the bowl and does not begin to float. Cover the bowl with cling film and place the small marble on the cling film directly above the mug. Use the pen to mark the water level on the outside of the bowl. Place the bowl in sunlight (e.g. on a window sill) and leave it for at least one hour.

Return to the bowl and describe what has happened. Has the water level changed? Are there any water droplets on the cling film? Is there any water in the mug?



You could try…

Find out what happens if water that has had some food colouring added to it is put in the bowl. What colour is the water that collects in the mug? In what ways does the coloured water in the bowl change?

What's happening?

What you are seeing is a water cycle. It's what happens to all water on planet Earth. Water in the bowl (like water on the surface of Earth) evaporates. This is speeded up by the warmth of the Sun. Water vapour condenses on the cling film (like it does in the air, forming clouds) and drips back into the mug (like rain). As this continues, water evaporates from both the bowl and the mug, condensing and dripping back into the mug.

Primary activity pack - Explore the future

Section 5: organiser notes

For each activity read through the pupil instructions to familiarise yourself with the method, making sure that the pupils understand what they are going to do.

Check the "You will need" lists to ensure that everything the pupils need is available. Extra materials may be required if trial runs or repeats are necessary.

Give pupils all of the equipment they need and make them aware of any health and safety issues; **a risk assessment should always be carried out before starting any practical work**.

Curriculum links

This activity pack provides lots of opportunity to use a range of investigative, practical and communication skills. Many areas of the curriculum for 5-11 year olds in England, Wales, Scotland and Northern Ireland are covered including:

England

Primary National Curriculum: Science

Life processes and living things: Living things in their environment (KS1&2)
Physical processes: Forces and motion (KS1&2), Light and sound (KS1&2), The Earth and beyond (KS2)

Primary National Curriculum: ICT

Exchanging and sharing information

Wales

Foundation Phase
Knowledge and Understanding of the World: Places and people

KS2 Science
Interdependence of organisms
The sustainable Earth
How things work

KS2 Information and communication technology
Create and communicate information

Scotland

Curriculum for excellence: sciences
Planet Earth: Energy sources and sustainability, Processes of the planet, Space

Curriculum for excellence: technologies
Technological developments in society

Northern Ireland

KS1&2 Areas of LearningThe World Around Us: Interdependence, Place, Movement and Energy

Activity 1: planetarium

When it’s turned on, a torch is a light source. Light travels in straight lines. It passes through transparent materials such as glass and clear plastic, but it doesn’t pass through opaque materials such as black paper, cardboard and metals.

Care must be taken when using sharp objects such as scissors and pins.

This activity can be used to get pupils thinking about space and stars. It could be used to introduce the work of ancient Greek astronomers.

Activity 2: fruit and veg solar system

Use the table below as a guide when choosing which fruit or veg represents each planet.

Planets in order from Sun	Fruit or veg to represent planet
Mercury	Pea
Venus	Cherry tomato
Earth	Cherry tomato
Mars	Blueberry
Jupiter	Watermelon
Saturn	Large grapefruit
Uranus	Large apple
Neptune	Small orange

If the planets were this size, the Sun would have a diameter of about 150 cm.

To make drawings and diagrams of the solar system fit on the page of a book and still be visible, an artist has to distort the sizes and distances.

Some planets are much bigger than others. For example, the diameter of the biggest planet, Jupiter, is more than ten times that of Earth.

It may also surprise pupils to learn just how much bigger the Sun is than any of the planets, even Jupiter.

Care must be taken when using scissors.

Pupils must not eat any of the fruit and veg, and should wash their hands thoroughly after handling.

Activity 3: how bright are the stars?

Stars gives out huge amounts of energy. They radiate light. How bright a star appears in the sky depends upon the amount of light it’s emitting and how far it is from Earth.

Care must be taken when using scissors.

Activity 4: organic food

The British Soil Association defines organic food as '*food which is produced using environmentally and animal friendly farming methods on organic farms*'. This means they are produced without the use of artificial fertilisers and agrochemicals such as pesticides and herbicides.

Testers use protocols or standard operating procedures to control variables and ensure consistency. Instructions for making hot chocolate drinks are typically: - *Sprinkle three heaped teaspoonful of the powder into a cup or mug of hot milk and stir well.*

If you wanted to test a new hot chocolate drink, these instructions would not be precise enough:

- *heaped* ... how much is this?
- *cup or mug* ... what volume of liquid can the cup or mug hold?
- *hot* ... what temperature is 'hot'?
- *milk* ... full cream, semi-skimmed or skimmed? How much milk?
- *stir well* ... how do you know when to stop stirring?

In a standard operating procedure these instructions would be more precise.

Supervision may be required if pupils need to use a knife to cut the food.

Make sure to check if the pupils have any food allergies. Give pupils the option to observe only if they do not want to taste the food.

Provide a means to mop up any spillages and make sure pupils know how to clear up appropriately.

Activity 5: plants to treat disease

Plants are chemical factories, able to make a huge variety of chemical substances. The Royal Botanic Gardens, Kew, says *Plants and fungi are a vital part of healthcare. 'Over 80% of the world's people rely on traditional medicine, much of which is based on plant remedies. Traditional Chinese medicine alone uses over 5,000 plant species*.'

Some of the hairs on the surface of plants, called glandular hairs, can make highly concentrated chemical compounds which are often useful for defence, for example, against insects. You can look at the surfaces of plants with a microscope to see if trichomes are present, or rub the surface to see if smelly compounds are released. The substances produced may also have medical benefits.

Care must be taken when using microscopes and handling microscope slides.

Pupils should wash their hands thoroughly after handling plant leaves.

Activity 6: capture-mark-recapture

Ecologists and environmental scientists use various techniques to investigate populations – the numbers and location of living things. This enables them to understand the health of an ecosystem and make important decisions about conservation.

It's impossible to count all the species and say where they are in a habitat. Sampling is essential. Plants are relatively easy since they don't move around. A quadrat is often used. Animals are another matter! Pitfall traps can be used to collect small animals. Larger animals are harder and the capture-mark-recapture technique is used.

Activity 7: fonts, bytes & bits

See 'What's happening?' section of activity.

Embedding text changes the amount of information that is in the file. Each piece of information that is stored in a file takes up a certain amount of space in the computer's memory. Since a computer has a limited amount of memory, the size of each file needs to be measured so that the computer can keep track of how much memory has been used and how much memory is free (still available to be used). The amount of space that a file uses is called the file size and is usually measured in kilobytes (abbreviated KB) or megabytes (abbreviated MB; 1 MB is equal to 1024KB).

Activity 8: how does SatNav work?

The Global Positioning System (GPS) is a network of about 30 satellites orbiting the skies above Earth. Each satellite transmits radio signals which can be picked up by devices such as a SatNav. No matter where you are on Earth, you can receive, signals from at least four satellites. Each satellite sends information at regular intervals – about its position and the current time. When a signal is received the distance between satellite and receiver is calculated from the time taken for the signal to arrive. As long as data are obtained from at least three satellites, the SatNav pinpoints your location using the principle you used. It's called trilateration.

Care should be taken when using sharp objects such as a drawing compass.

Activity 9: hovering trains

A Maglev train uses the same magnetic principles as demonstrated in this activity. These videos show the effect in action:
http://www.youtube.com/watch?v=VuSrLvCVoVk and
http://www.youtube.com/watch?v=Bkoz8aEUssQ.

Activity 10: which way should my solar panel face?

Because we in the UK are in the northern hemisphere, and the Sun is above the equator, solar panels should be south facing. If they face south then they will be facing the Sun from when it rises to when it sets.

There are two types of solar panel. In one, energy from the Sun warms water that trickles through it pipes in the panel. The other type contains photovoltaic cells. These produce electricity when sunlight shines on them. Both types have the problem ‘what happens at night or on a cloudy day?’ The answer is to find ways of storing the energy and releasing it when it’s needed.

Care must be taken not to drop any heavy weights.

Activity 11: the greenhouse effect

The Sun gives us light and warmth. Sunlight comes through the atmosphere. Some is used by plants to make them grow (photosynthesis). Most is absorbed by Earth’s surface and reflected back, but in a different form. Not all of it can escape back into space. It’s trapped. This is called the greenhouse effect.

Activity 12: rain in a bowl

The water cycle is what happens to all water on planet Earth. It is the continuous movement of water from the Earth’s surface to the atmosphere and back again. Energy from the Sun heats the water causing it to evaporate, creating water vapour. The water vapour rises into the atmosphere, cools down, and then condenses back into liquid. The liquid droplets grow and become heavier until eventually they fall back to the Earth’s surface as precipitation (e.g. rain or snow).

Care should be taken when handling glass.

Provide a means to mop up any spillages.

Section 6: group activity

Wind powered cars

What you need

An electric fan and a range of everyday, household materials and art and craft supplies, such as: straws, dowling, craft sticks (e.g. lollipop sticks), card, paper, fabrics, paper clips, plastic cups and containers, 'wheels' (e.g. cotton reels, buttons, MDF wheels), rubber bands, ruler, scissors, string, sticky tape, glue

What to do

Have you ever thought about how much pollution is caused by transport? Nowadays, people are encouraged to walk, cycle and take public transport as much as possible. But another solution is to make transport more eco-friendly.

Wind has powered boats and ships for centuries. People have used sails and wind turbines.

However, it's not easy to test different types of sails or wind turbines on boats and ships. It's easier to try them out on model cars. Your challenge is to design a wind-powered car.

Work in groups of 4-6 people. Which group can make a car that travels furthest from a wind source (electric fan)? Which group can make the car that can pull the most number of paper clips behind it?

Keys points for pupils to think about:

1. How will you divide up the work between the people in your group?
2. How big will your model be?
3. What will you use for the base of your car?
4. How will you attach the wheels?
5. Do the wheels move freely? Why is this important?
6. How will your car harness the wind to move it along? Design and make a sail or a wind turbine.
7. Can you modify your car in any other way to help it 'catch' the wind and help it travel further?
8. How heavy do you want your car to be? Why does this matter?

Background information

Car pollution can harm the environment. When petrol or diesel is used to fuel cars, exhaust fumes are emitted that contain carbon dioxide. This contributes to global warming. Fumes may also contain small quantities of poisonous gases such as carbon monoxide and oxides of nitrogen, though catalytic convertors in modern cars reduce these hugely.

Alternative fuel solutions are being sought; such as cars powered by electricity. However, the electricity still needs to be generated – and the main way of doing this involves burning fossil fuels.

Another alternative would be solar powered cars. These cars use photovoltaic (PV) cells that use sunlight to generate electricity.

This group activity is about the design and construction of wind-powered cars, but you can also try making a model solar-powered car. You will need a small electric motor and a PV cell.

How does wind propel a vehicle? The wind from the fan blows into the sail or wind turbine. The force of the wind causes the car to move. The more powerful the wind, the faster and further the car will travel. The car will also travel further if the amount of friction involved is reduced – the wheels must move freely and not rub, and the car shouldn't be too heavy.

Section 7: CREST Star investigation

Rocket science

Have you been on holiday in an aeroplane, or watched the launch of a space shuttle on TV? Have you ever wondered how these huge objects get up into the air?

This activity involves making a balloon rocket and investigating how it moves.

Talk about

1. What happens when an aeroplane takes off or a rocket is launched into space? How do you think they get off the ground?
2. What happens when you blow up a balloon and let it go? What do you think makes it move?

Here are some things to get you started

1. Blow up a balloon and let it go. What would happen if an aeroplane or rocket took off like that?
2. How could you make the balloon go in a straight line? You might need to ask your teacher what materials you will be able to use to make your balloon rocket.
3. How do you think you can you make the balloon rocket go a long way or go only a short way?
4. Ask your teacher for the materials to make your balloon rocket.
5. Make your balloon rocket and set things up ready for testing. You may need to ask your teacher for help.
6. Have you made sure that it's a fair test?

Sharing your ideas

Did your balloon rocket work? Can you explain how? Were you able to make your rocket travel different distances? If so, how did you do it?

Here are some extra challenges

- What happens if you use different shaped balloons?
- What happens if you change the length of the straw?
- What happens if you use different types of 'string' (e.g. wool, cotton)?
- What happens if you only let the air come out slowly?
- Can you design a balloon rocket to travel as far as possible?

Rocket science - organiser’s notes

What do I do?

1. Familiarise yourself with the activity and check the resources list.
2. Discuss what happens when you blow up a balloon and let it go. Establish that the air comes out of the balloon and the balloon flies around the room in chaotic and random directions.
3. Discuss the problem aeroplanes and rockets would have if they moved in this way.
4. Give the pupils time to think about how they could make their balloon rocket travel in a straight line. Make sure they all know how to make their rocket and can set up the investigation correctly:

   Stand two chairs, back to back, about three metres apart. Cut a piece of string long enough to tie between each chair. Thread the string through a straw. Tie one end of the string to one chair and tie the other end to the other chair. Make sure the string is pulled tight – move the chairs further apart if necessary. Blow up a balloon and squeeze the end to make sure no air escapes. A crocodile clip would be useful to pinch the opening of the balloon so that you have both hands free. Carefully attach the balloon, horizontally, to the straw. This is your balloon rocket. Move the balloon rocket to the end of the string so that the balloon opening is next to the chair. Remove the crocodile clip.
5. Give the pupils time to think about how they could make their rocket travel different distances. Explain that they cannot change or add any other materials at this point.
6. Give the pupils the equipment and materials needed.

Background

In generations to come, space travel could become relatively common. There are already space stations and people have walked on the moon. There has even been talk about mining asteroids. But any talk of space exploration begins with one question. How do we get the rocket and its payload into space?

Rockets burn fuel. They produce large quantities of hot gas from a small amount of liquid or solid fuel. The engine releases these gases through the bottom of the rocket. The rocket is powered forward as the escaping gases push it off the ground.

In this investigation, thrust is created by the air rushing out of the balloon. It is mimicking the gases produced when rocket fuel burns. The balloon squeezes out all of, the air but the air also pushes back against the balloon making it ‘fly’.

The more air in a balloon the greater the push when it escapes. A sudden rush of air gives a bigger push than a more controlled release of air. It’s straightforward to demonstrate this. How far the balloon is pushed depends on the amount of air in the balloon. Resistance to movement is caused by air pressure and friction between the straw and the string.

Extra challenges

Changing the size and shape of the balloon can cause more or less thrust to be created. Balloons that hold more air will generate greater thrust. Some balloons, such as long thin balloons, may travel further because they have a more aerodynamic shape.

Changing the length of the straw and type of string can affect the distance that the balloon rocket travels. This is due to the friction produced between the surface of the straw and the string. The smoother the surface and the less contact between surfaces (i.e. a shorter straw), the less friction will be produced, allowing the rocket to travel further.

You could also experiment by adding payloads, e.g. by taping different masses to the balloon.

Suggested materials

String, scissors, drinking straws, balloons, two chairs, sticky tape, crocodile clips

Safety points

Care should be taken when using scissors.

Check that pupils don't have any allergies that affect them handling balloons.

Try not to pop the balloons!

Section 8: CREST Superstar investigation

Keeping food

We all need to eat. However, there are lots of children around the world who are starving.

To make sure everybody gets the food they need we have to:

- grow enough
- get it to the people who need it
- make sure it doesn't go off (become nasty to eat and sometimes make you ill).

This activity is about ways to stop food from going off.

Talk about

1. What food do you like to eat?
2. Where does the food you eat come from?
3. What's the difference between 'fresh' food and 'processed' food?
4. Why do shops put 'sell buy' and 'use by' dates on food?

Here are some things to get you started

1. Look around your local shop or supermarket. How many different things can you find that began as a:
   - ripe tomato
   - fresh potato
   - juicy orange?

   (a) Leave some biscuits and pieces of fresh bread on a plate

   (b) Leave some fresh fruit and vegetables on a plate

   In each case: How do they change over time? Look, smell, and prod with a wooden spoon. Don't taste!
2. Cut some fresh fruit and vegetables into small pieces. How do they change over time? Look, smell, and prod with a wooden spoon. Don't taste! Is there any difference where the piece is partly covered by skin or peel?
3. What packaging is used to make sure cornflakes don't become soft while they are sitting in a kitchen cupboard?
4. Apples turn brown when they are peeled or cut into pieces. How can you stop this happening or, at least, happen more slowly? Hints: lemon juice, fridge, cling-film.
5. Some changes happen to foods quite quickly, others more slowly and some very slowly. How could you measure the speed that food change?

Sharing your ideas

What did you discover? What happened to the different foods? How did the different foods change? Can you explain what happened?

Here are some extra challenges

- What happens when different fresh fruits and vegetables are frozen and then defrosted?
- What happens to bread if it's kept in a warm moist place?
- Why is salt used to preserve some meat and some vegetables?

Keeping food - organiser's notes

What do I do?

1. Familiarise yourself with the activity and check the resources list.
2. Discuss what food children eat and decide what is 'fresh' and what is 'processed'. Establish a list of both types. Discuss the problems of storing food and how much is thrown away and wasted because it has gone off.
3. Give the pupils the time to think about what foods they would like to test and compare.
4. Ensure that pupils understand that this investigation involves and careful observation and comparison.

5. Give the pupils time to think about what they could do to investigate and compare different foods. They may need help and direction when discussing their ideas to ensure they decide on a suitable investigation that is possible to carry out.
6. Give them the equipment needed.

Background

Feeding the world's population is a major global challenge, now and increasingly in the future. Most of the food we eat comes from plants and animals that are no longer living. All dead organisms rot and decay. It's part of a natural process that scientists often call the carbon cycle.

Growing sufficient food is one thing – using it before it decays and becomes harmful to us is another. Scientists and technologists have developed many ways to store food and slow down the decay process. This is one of the keys to providing food to the world's population in the future.

Pupils could be directed to one of three simple experiments that will provide a comparison between processed food and natural food. They will be able to observe differences between how quickly the foods go off.

Softening biscuits

Pupils put some hard, crispy biscuits on a plate and leave them in the open. The biscuits become soft and pliable (they don't snap as easily when being bent). This doesn't affect the food value, but it changes the texture of the biscuit. The biscuits probably tasted good because they were crispy, so while the change doesn't affect their food value, the change in texture makes them less good to eat.

- Biscuits become soft because they absorb water from the air (dipping biscuits in tea speeds up the process!). Many people explain that the difference between a cake and a biscuit is that cakes become hard, but biscuits become soft.

Growing mould

Pupils take same-size pieces of a variety of different foods and place them in a warm, dark place. Over a period of time, they observe what happens to the food and the growth of mould. Bread is a good example. A decaying peach also works well.

- The mould is a fungus. They grow in moist, warm, dark conditions from spores.

Browning apples

Pupils put slices of apple on a plate. They pour lemon juice over some of the pieces. Over a few hours they notice that the 'untreated' pieces of apple have become brown (some types of apple – the softer ones usually – brown more quickly). In contract, those that had lemon juice poured over them had not change (at least, not very much). If they are careful, pupils could pour lemon juice over just one end of an apple slice.

- Apples brown (as do other fruit and vegetables) when they are in contact with air. Oxygen in the air reacts with substances in the apple to make new compounds that have a dark colour. Reactions with oxygen are called oxidation.

Pupils will be able to observe changes in fresh fruit and vegetables and in processed foods such as bread. They should record their observations in a logbook over time. They could draw pictures or take photographs and write short descriptions of what has happened.

Extra challenges

Freezing and defrosting can affect the texture of some foods. This is because water in the food freezes and forms ice. When ice melts it expands. The ice forms in the plant or animal cells. This can rupture the cells when the ice melts, often making the food softer than before freezing.

Mould is a fungus. It grows from spores in the air that settle on the surface of, for example bread, and begin to grow. The ideal conditions for growth are moisture and warmth.

Salt draws water out of some foods. It is a desiccant. In other words, it dries the fresh food and this slows down the decay processes. In particular, water is drawn out of cells by a process called osmosis.

Suggested materials

Fresh fruit, fresh vegetables, bread, biscuits, cereals such as cornflakes, lemon juice, sealable plastic bags, cling-film, aluminium foil.

Safety points

- The food and drink used in this activity is for investigative purposes only
- Pupils must be told **not** to eat anything
- Hands **must** be washed thoroughly after handling food – Ensure that there is access to soap and water (and antibacterial hand gel if possible) so that pupils can wash their hands during and after the experiments
- Keep food and drink used in this activity **separate** from food for consumption
- Care must be taken if pupils use a knife to cut the food themselves.

For older pupils

Pupils could design an experiment to find out how quickly different types of biscuit go soft. They need a way to test the softness. A dent test might be one way – simply dropping a mass on the biscuit to see if it breaks (showing the biscuit is brittle) or if it is just deformed (e.g. squashed or dented).